Angular Momentum Limit in Cold Fusion Reactions

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A systematic investigation of the conditions populating exotic nuclear states of triaxial superdeformed and hyperdeformed shapes, which are only expected to be populated at very high spins, was performed at the 88–Inch Cyclotron using the 8π–Spectrometer. The compound nucleus ^{168}Hf was populated in three reactions with different mass asymmetries: ^{50}Ti+^{118}Sn, ^{64}Ni+^{104}Ru and ^{74}Ge+^{94}Zr. Due to the large negative Q–value of these reactions, ^{168}Hf was formed at low excitation energies. The relative yields of the evaporation residues ^{166}Hf to ^{163}Hf, and the multiplicity and total energy of the γ–rays were measured at three or four different excitation energies for each reaction.

Multiplicity distributions of the γ–rays are shown in Fig. 1 [1]. We found that the maximum angular momentum transfer in the different exit channels does not depend on the mass–asymmetry of the reaction. The energy dependence of the multiplicity distributions shows that the limiting angular momenta are reached already at the lowest bombarding energies in the 2n channels and at higher energies in the 3n channels. The limiting multiplicities are $M_{lim} = 28.3(0.9)$ for ^{166}Hf and 27.0(0.9) for ^{165}Hf, where M_{lim} is the value where the distribution drops to one half of the maximum.

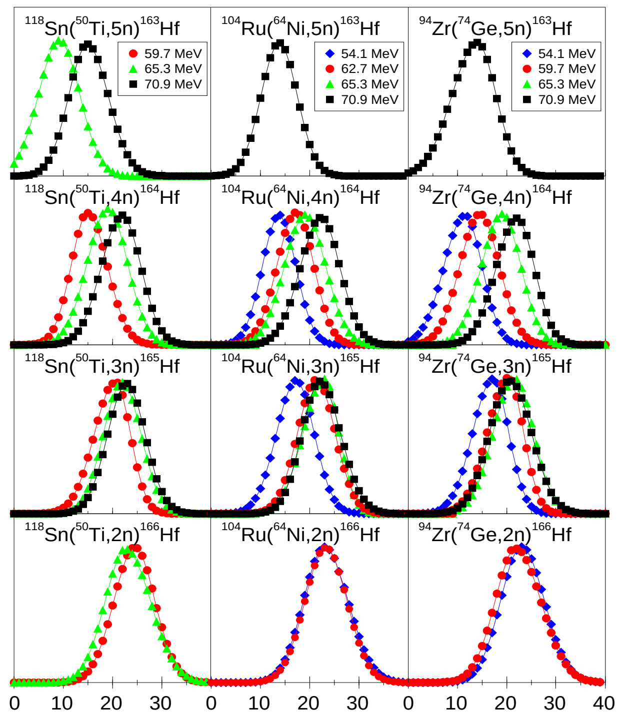

Figure 1: Multiplicity distributions for the different reaction channels and excitation energies.

The analysis of the relative cross sections revealed a strong enhancement of the channels with low neutron multiplicity, especially of the 2n channel. The ratios R=σ(2n)/σ(4n) are 0.56(3) and 0.43(2) for the ^{64}Ni and ^{74}Ge induced reactions, respectively, at the lowest excitation energy of 54.1 MeV. This is about a factor of three higher than predicted by statistical model calculations. This discrepancy might be due to an insufficient knowledge of the energy of the yrast line at very high spins. Because of this enhancement and the high angular momentum transfer, the exit channels with low neutron multiplicity in near–symmetric cold fusion reactions might be advantageous for the population of states at very high spin, in particular those with extreme deformation.

[1] J. Domscheit et al., Nucl. Phys. A, in press